

**Centaurea solstitialis L.**  
**Saint Barnaby's Thistle, Yellow Star Thistle**

**Description.** Annual, sometimes biennial, herbaceous, from a stout taproot; stems 10-100 cm tall, erect, winged, gray-tomentose, becoming glabrous, branched throughout, branches erect to ascending or spreading. Basal leaves oblanceolate, 3-20 cm long, 0.5-5 cm wide, pinnately 1-5-lobed, the lobes oblong, entire to toothed, the base tapered, senescent before flowering; cauline leaves linear to narrowly lanceolate, margins entire, bases decurrent with the stem wings, surfaces loosely tomentose. Heads discoid (all corollas radial and salverform), 18-22 mm long, the involucre 10-17 mm long, 7-9 mm wide, ovoid to subglobose, stalked, solitary. Phyllaries ovate, pale green to yellowish brown, tomentose, becoming glabrous, margins scarious, apices terminating in a palmately spinose appendage, the lateral spines much shorter than the terminal one, the terminal spines widely spreading, 11-30 mm long, yellow. Corollas 13-20 mm, bright yellow, nonglandular. Achenes 2-3.5 mm long, obovoid, glabrous, of two forms, the inner achenes pale yellow to tan, often brown-mottled, with pappus composed of white bristles, 2-5 mm long, outer achenes dark brown, pappus absent. Flowering in California from May to October (Barkley 1986, Clapham et al. 1962, Cronquist 1994, Dostal 1976, Keil and Turner 1993, Munz 1959).

The related species, *Centaurea melitensis* L. (Tocalote), differs by having phyllaries with pinnately spined terminal appendages, the terminal spine 5-10 mm long, glandular corollas, and achenes of one form, greyish to light brown, all with pappus bristles.

**Geographic distribution.** A native of Mediterranean Europe and North Africa, yellow starthistle has become naturalized throughout northern Europe, Australia, New Zealand, and western North America (Clapham et al. 1962, Dostal 1976, Webb et al. 1988). It is widespread throughout the United States, especially in the west (Maddox and Mayfield 1985, Maddox et al. 1985, Roche and Roche 1988).

Yellow star thistle is believed to have been introduced into California sometime between 1825 and 1848 (Frenkel 1970), but Roche and Roche (1988) report that it was first introduced into the Pacific Northwest about 1920.

In California, it has been reported from 30 counties, including the coast, the Central Valley, and southwestern California west of the deserts (Anonymous 1998); it also occurs on Santa Catalina and Santa Cruz islands (Junak et al. 1995).

**Ecological distribution.** Yellow star thistle commonly occurs in cultivated fields, fallow fields, along roadsides, rangelands, and in vacant urban lots (Barkley 1986, Cronquist 1994, Keil and Turner 1993, Munz 1959). It is believed to be spread as an impurity in hay, commercial seed mixes, and by livestock (Maddox and Mayfield 1985, Maddox et al. 1985, Robbins et al. 1970, Roche and Roche 1988).

**Reproductive and vegetative biology.** Yellow star thistle is self-compatible, but requires pollination by insects to ensure high levels of seed set (DiTomaso 1996, Harrod and Taylor 1995). The feral bee, *Apis mellifera*, is an important and effective pollinator; yellow star thistle populations are sought out by bee keepers for the quality of their nectar (DiTomaso 1996,

Wenner and Thorp 1984). Seeds are dispersed by either wind or by birds (Roche 1992). Frenkel (1970) reported finding up to 10 seeds per square foot following natural dispersal along roadsides in central California. Sheley and Larson (1994) estimated a reproductive capacity of 5,200 (dry years) to 21,600 (moist years) seeds per square meter in Washington.

Seeds can retain high viability and germinability after burial for more than one growing season (Callihan et al. 1993, Northam et al. 1989). Germination usually takes place during the winter months (December through February), but may continue through July, providing sufficient moisture is available (Thomsen et al. 1994). Differences in viability and germinability, especially under water stress, are correlated with achene dimorphism, but both forms show relatively long-term viability (Callihan et al. 1993, Larson and Kiemnec 1997). Germination and success of establishment is partly related to depth of seed burial (Sheley and Larson 1995, 1997). Studies of experimentally buried seeds showed that up to 77% of buried seeds remain germinable after 2 years; higher proportions of seeds remained more germinable at depths of up to 5 cm than those near or at the surface (Joley et al. 1992). Roche et al. (1994) suggest that light intensity at the soil surface and moisture content of soils are critical factors determining success of seedlings and young vegetative rosettes.

Based on life history studies in Washington, Sheley and Larson (1994) showed that highest mortalities occurred during the transition between seedlings and young leaf rosettes and the transition between leaf rosettes and flowering stages. This suggests that control methods applied during these periods may have a significant effect on reproductive capacity of adult plants expressed in terms of seed output.

Interactions between yellow star thistle and both alien and native grasses have been studied, primarily in the Pacific Northwest. Experimental studies of competition between yellow star thistle and both alien annual grasses or native bunchgrasses in the Pacific Northwest provide evidence that yellow star thistle is a better competitor for water, especially between the seedling and pre-bolting rosette stages. This is attributable to earlier germination and growth during the first few months of the growing season, and to a more rapid and deeper root growth than its competitors (Borman et al. 1992, Prather and Callihan 1991, Roche et al. 1994, Sheley et al. 1993, Sheley and Larson 1993). Depth of seed burial also enhanced success of star thistle, at least in competition with cheat grass (Sheley and Larson 1995, 1997). Yellow star thistle was less successful in the presence of perennial grasses or dense herbaceous cover than in open, annual grasslands (Roche et al. 1994).

**Weed status.** Although not considered globally noxious (not listed by Holm et al. 1977), yellow star thistle is considered one of the most abundant, noxious, and invasive weeds in the western United States and Canada, especially in disturbed annual grasslands, fallow fields, and rangelands (Roche and Roche 1988, Maddox and Mayfield 1985, Maddox et al. 1985b, Sheley and Larson 1994, Thomsen et al. 1989). It also is considered one of the most invasive noxious weeds in California by the State Dept. of Food and Agriculture (Anonymous 1996).

**Fungal pathogens.** At least one rust fungus (*Puccinia jaceae*) has been reported to infest yellow star thistle (Bruckart 1989) and a soil-borne fungus (*Aschocyta*) is known to infest the roots (Pitcairn 1997).

**Insect pathogens.** A number of studies have investigated the potential for control of yellow star thistle by phytophagous insects (Maddox et al. 1986, Pitcairn 1997, Turner 1991, 1994). These include weevils (Fornasari et al. 1991, Maddox et al. 1991, Wood 1993), Lepidoptera (Clement 1990), and gall flies (Maddox et al. 1990, Turner 1994, Turner et al. 1994, White et al. 1990), which, depending on species, feed on all parts of the plant in native European habitats (Clement 1990, Wood 1993). Clement (1990) reported finding at least 5 insects that might prove beneficial for control purposes, because they feed specifically on developing flowers. Native insects also have been found to feed on leaves and flowers (Johnson 1992)

Experimental studies of naturalized strains in Italy showed, however, that not all populations of yellow starthistle are equally susceptible to herbivory by European insects (Clement 1994). Furthermore, some European fruit flies preferred American strains of star thistle. Thus, there appear to be differences among naturalized strains with respect to susceptibility to infestation. However, the potential effect of introduced phytophages on native American thistles remains unknown (Turner 1991, 1994).

**Herbicide control.** Ditomaso (1997) provided a general review of both pre-emergent and post-emergent herbicides useful in controlling yellow starthistle. Several different kinds have been used with varying success depending on field conditions (Elmore 1994, Northam and Callihan 1989, Northam 1989). Effective herbicides include hexazinone (Ahrens 1994), oxyflourfen (Elmore 1994), picloram (Larson 1989), pyridine herbicides (Callihan et al. 1991, Callihan and Schirman 1991), and the latter in combination with atrazine (Lass 1993). Several researchers have reported variation in response to picloram herbicides, including evidence for resistance in wild populations (Callihan 1991, Fuerst et al. 1996, Northam and Callihan 1990).

**Other control methods.** Several other control methods, all dependent on field conditions and extent of infested acreage, include mowing combined with with clover cultivation (Thomsen et al. 1997), prescribed burns (Hastings 1996, Rusmore 1996), and grazing (Thomsen et al. 1993, Thomsen et al. 1994). Timing of grazing is critical to reproductive success and control. Plants grazed during the rosette stage produced higher numbers of flowers and fruits than when grazed during early bolting, just prior to development of spiny leaves (Thomsen et al. 1997). Grazing with horses is not recommended, because prolonged ingestion of star thistle causes a fatal nervous disease (Cordy 1954, 1978). Prescribed burns and, in some cases, mowing have been especially successful, if applied during the full vegetative rosette stage but before germination of associated annual species (Rusmore 1996).

### Literature Cited

- Ahrens, W. 1994. Herbicide handbook. 7th Edition. Weed Science Society of America, Champaign, Illinois. 352 pp.
- Anonymous. 1998. USDA Plants Database. USDA National Plants Data Center, New Orleans, Louisiana. URL: usda.plants.gov
- Anonymous. 1996. Exotic pest plants of greatest ecological concern in California as of August 1996. California Exotic Pest Plant Council. 8 pp.
- Barkley, T. 1986. Asteraceae. pp. 838-1031. In Great Plains Flora Association. 1986. Flora of the Great Plains. University of Kansas, Lawrence. 1392 pp.

- Black, J. 1965. Flora of South Australia. Part IV. Oleaceae-Compositae. W. L. Hawkes, Government Printer, Adelaide. pp. 685-1008.
- Borman, M., D. Johnson, and M. Krueger 1992. Soil moisture extraction by vegetation in a Mediterranean/maritime climatic regime. *Journal of the American Society of Agronomy*. 84: 897-904.
- Bruckart, W. 1989. Host range determination of *Puccinia jaceae* from yellow starthistle. *Plant Disease*. 73: 155-160.
- Callihan, R.H., L. Lass, and F. Northam. 1991. The effects of pyridine herbicides in combination with atrazine for grass establishment in yellow starthistle habitat. Research Progress Report, Western Society of Weed Science. pp. 16-19.
- Callihan, R. and R. Schirman. 1991. Effects of five hormone-type herbicides on the survival of yellow starthistle seedlings from a known susceptible population and a suspected picloram resistant population. Research Progress Report, Western Society of Weed Science. pp. 40-42.
- Callihan, R., T. Prather, and F. Northam. 1993. Longevity of yellow starthistle (*Centaurea solstitialis*) achenes in soil. *Weed Technology* 7: 33-35.
- Clapham, A., T. Tutin, and E. Warburg. 1962. Flora of the British Isles. Cambridge University Press, Cambridge. 1269 pp.
- Clement, S. 1990. Insect natural enemies of yellow starthistle in southern Europe and the selection of candidate biological control agents. *Environmental Entomology*. 19 : 1882-1888.
- Clement, S. 1994. Resistance among populations of yellow starthistle to thistle-head insects: results from garden plots in Italy. *Biological control : theory and applications in pest management*. 4: 149-156.
- Cordy, D. 1954. Nigropallidal encephalomalacia in horses associated with ingestion of yellow starthistle. *Journal of Neuropathology and Experimental Neurology* 13: 330-342.
- Cordy, D. 1978. *Centaurea* species and equine nigropallidal encephalomalacia. pp. 327-336. In Keeler, R., K. Van Kampen, and L. James (eds.). *Effects of poisonous plants on livestock*. Academic Press, New York.
- Cronquist, A. 1994. Asterales. Intermountain flora: vascular plants of the intermountain west, U.S.A. The New York Botanical Garden, Bronx. 496 pp.
- DiTomaso, J. 1996. Pollination biology of yellow starthistle (*Centaurea solstitialis*) in California. *Canadian Journal of Botany*. 74: 262-267.
- DiTomaso, J. 1997. Yellow starthistle: chemical control. pp. 81-84. In J. Lovich, J. Randall, and M. Kelly (eds.) *Proceedings, California Exotic Pest Plant Council Symposium*. California Exotic Pest Plant Council. Sacramento, CA. 110 pp.
- Dostal, J. 1976. *Centaurea*. pp. 254-301. In Tutin et al. (eds.) *Flora Europaea*. Volume 4. Plantaginaceae to Compositae. Cambridge University Press, Cambridge. 505 pp.
- Elmore, C. 1994. Chemical control of yellow starthistle. *Proceedings, 46th California Weed Conference*. pp 231-233.
- Fornasari, L., C. Turner, and L. Andres. 1991. *Eustenopsis villosus* (Coleoptera: Curculionidae) for biological control of yellow starthistle (*Centaurea solstitialis*) in North America. *Environmental Entomology* 20: 1187-1194.
- Frenkel, R. Ruderal vegetation along some California roadsides. *University of California Publications in Geography*. 20: 1-163.

- Harrod, R. and R. Taylor. 1995. Reproduction and pollination biology of *Centaurea* and *Acroptilon* species, with emphasis on *C. diffusa*. Northwest Science. 69: 97-105.
- Hastings, M. 1996. Fire controls yellow star thistle in California grasslands. Restoration & Management Notes. 14: 124-128.
- Johnson, J.B. 1992. Endemic phytophagous insects associated with yellow starthistle in northern Idaho. The Pan-Pacific entomologist. 68: 169-173.
- Joley, D., D. Maddox, D. Supkoff, and A. Mayfield. 1992. Dynamics of yellow starthistle (*Centaurea solstitialis*) achenes in field and laboratory. Weed Science. 40: 190-194.
- Junak, S., T. Ayers, R. Scott, D. Wilken, and D. Young. 1995. A flora of Santa Cruz Island. California Native Plant Society and the Santa Barbara Botanic Garden. 397 pp.
- Keil, D. and C. Turner. 1993. *Centaurea*. pp. 222-223. In Hickman, J. (ed.). The Jepson Manual: higher plants of California. University of California Press, Berkeley. 1400 pp.
- Larson, L. 1989. Response of yellow starthistle (*Centaurea solstitialis*) and grass biomass to grass, picloram, and fertilizer combinations. Weed Technology 3: 497-500.
- Larson, L. and G. Kiemnec. 1997. Differential germination by dimorphic achenes of yellow starthistle (*Centaurea solstitialis* L.) under water stress. Journal of Arid Environments. 37: 107-114.
- Maddox, D. and A. Mayfield. 1985. Yellow starthistle infestations are on the increase. California Agriculture 39: 10-12.
- Maddox, D., A. Mayfield, and N. Poritz. 1985. Distribution of yellow star thistle (*Centaurea solstitialis*) and Russian Knapweed (*Centaurea repens*). Weed Science 33: 315-327.
- Maddox, D., R. Sobhian, D. Joley, A. Mayfield, and D. Supkoff. 1986. New biological control for yellow starthistle. California Agriculture 40: 4-5.
- Maddox, D., A. Mayfield, and C. Turner. 1990. Host specificity of *Chaetorellia australis* (Diptera: Tephritidae) for biological control of yellow starthistle (*Centaurea solstitialis*, Asteraceae). Proceedings of the Entomological Society of Washington. 92: 426-430.
- Maddox, D., B. Joley, A. Mayfield, and B. Mackey. 1991. Impact of *Bangasternus orientalis* (Coleoptera: Curculionidae) on achene production of *Centaurea solstitialis* (Asterales: Asteraceae) at a low and high elevation site in California. Environmental Entomology 20: 335- 337.
- Munz, P. 1959. A flora of California. University of California Press, Berkeley. 1681 pp.
- Northam, F. 1989. The effects of herbicides on the species composition of an annual weed community. Research Progress Report, Western Society of Weed Science. pp. 112-115.
- Northam, F., T. Prather, and R. Callihan. 1989. Viability and germination of buried yellow starthistle seed. Research Progress Report, Western Society of Weed Science. pp. 124-126.
- Pitcairn, M. 1997. Yellow starthistle control methods: biological control. pp. 77-80. In J. Lovich, J. Randall, and M. Kelly (eds.) Proceedings, California Exotic Pest Plant Council Symposium. California Exotic Pest Plant Council. Sacramento, CA. 110 pp.
- Prather, T. and R. Callihan. 1991. Interference between yellow starthistle and pubescent wheat-grass during grass establishment. Journal of Range Management. 44: 443-447.
- Roche, B. 1992. Achene dispersal in yellow starthistle (*Centaurea solstitialis* L.). Northwest Science 66: 62-65.
- Roche, C. and B. Roche. 1988. Distribution and amount of four knapweed (*Centaurea* L.) species in eastern Washington. Northwest Science. 62: 242-253.

- Roche, B. C. Roche, and R. Chapman. 1994. Impacts of grassland habitat on yellow starthistle (*Centaurea solstitialis* L.) invasion. *Northwest Science* 68: 86-96.
- Rusmore, J. 1996. Use of fire and cutting to control yellow starthistle. pp. 13-19. In J. Lovich, J. Randall, and M. Kelly (eds.) *Proceedings, California Exotic Pest Plant Council Symposium*. California Exotic Pest Plant Council. Sacramento, CA. 64 pp.
- Sheley, R. and L. Larson. 1993. Comparative growth and interference between cheatgrass and yellow starthistle seedlings. *Journal of Range Management*. 47: 470-474.
- Sheley, R. and L. Larson. 1995. Interference between cheatgrass and yellow starthistle at 3 soil depths. *Journal of Range Management*. 48: 392-397.
- Sheley, R. and L. Larson. 1997. Cheatgrass and yellow starthistle growth at 3 soil depths. *Journal of Range Management* 50: 146-150.
- Sheley, R., L. Larson, and D. Johnson. 1993. Germination and root dynamics of range weeds and forage species. *Weed Technology* 7: 234-237.
- Thomsen, C., W. Williams, M. George, W. McHenry, F. Bell, and R. Knight. 1989. Managing yellow starthistle on rangeland. *California Agriculture*. 43: 4-7.
- Thomsen, C., W. Williams, M. Vayssieres, F. Bell, and M. George. 1993. Controlled grazing on annual grassland decreases yellow starthistle. *California Agriculture*. 47: 36-40.
- Thomsen, C., M. Vayssieres, and W. Williams. 1994. Grazing and mowing management of yellow starthistle. *Proceedings, 46th California Weed Conference*. pp. 228-230.
- Thomsen, C., W. Williams, and M. Vayssieres. 1997. Mowing and subclover plantings suppress yellow starthistle. *California Agriculture*. 51: 15-20.
- Thomsen, C., M. Vayssieres, and W. Williams. 1997. Yellow starthistle management with grazing, mowing, and competitive plants. pp. 65-71. In J. Lovich, J. Randall, and M. Kelly (eds.) *Proceedings, California Exotic Pest Plant Council Symposium*. California Exotic Pest Plant Council. Sacramento, CA. 110 pp.
- Turner, C. 1991. Biological control of yellow starthistle, *Centaurea solstitialis* L.: a progress report. *Proceedings, 43rd California Weed Conference*. pp 78-82.
- Turner, C. 1994. Biological control of yellow starthistle: 1994 update. *Proceedings, 46rd California Weed Conference*. pp 224-227.
- Turner, C. 1994. Host specificity and oviposition of *Urophora sirunaseva* (Hering) (Diptera: Tephritidae), a natural enemy of yellow starthistle. *Proceedings of the Entomological Society of Washington*. 96: 31-36.
- Turner, C., R. Sobhian, D. Joley, E. Coombs, and G. Piper. 1994. Establishment of *Urophora sirunaseva* (Hering) (Diptera: Tephritidae) for biological control of yellow starthistle, *Centaurea solstitialis* in the western United States. *Pan-Pacific Entomologist* 70: 206-211.
- Webb, C., W. Sykes, and P. Garnock-Jones. 1988. *Flora of New Zealand*. Volume 4. Naturalized pteridophytes, gymnosperms, dicotyledons. Department of Scientific and Industrial Research, Christchurch. 1365 pp.
- Wenner, A. and R. Thorp. 1994. Removal of feral honey bee (*Apis mellifera*) colonies from Santa Cruz Island. pp. 513-522. In Halvorson and Maender. *The fourth California islands symposium: update on the status of resources*. Santa Barbara Museum of Natural History, Santa Barbara. 530 pp.
- White, I.M., K. Groppe, and R. Sobhian. 1990. Tephritids of knapweeds, starthistles and safflower: results of a host choice experiment and the taxonomy of *Terellia luteola* (Wiedemann) (Diptera: Tephritidae). *Bulletin of Entomological Research*. 80: 107-111.

- Wilken, D., 1998. California county flora database version 2, Santa Barbara Botanic Garden and USDA National Plants Data Center, Santa Barbara and New Orleans.
- Wood, M. 1993. Weed-eating insects take the starthistle challenge. Agricultural Research (USDA, ARS) 41: 10-11.